UKR Journal of Medicine and Medical Research (UKRJMMR)
Homepage: https://ukrpublisher.com/ukrjmmr/
Email: submit.ukrpublisher@gmail.com
Volume 2, Issue 6, November-December 2026 ISSN: 3107-5061 (Online)

Addressing Maternal and Family Health Challenges Through Preventive and Personalized Medicine

Evelyn Uzoamaka Onwuka[1], Micheal Abimbola Oladosu[2]*, Moses Adonduah Abah[3] & Odu Ruth Odey[4]

[1]Department of Medicine, International University of the Health Sciences, Frigate Bay Basseterre, St. Kitts, West Indies. *ORCID number: 0009-0002-5091-6343*

[2]Department of Chemical Sciences, Faculty of Science, Anchor University, Lagos, Nigeria. *https://orcid.org/0009-0000-5098-1247*

[3]Department of Biochemistry, Faculty of Pure and Applied Sciences, Federal University of Wukari, Wukari Taraba State, Nigeria. *https://orcid/0000-0002-9268-1661*

[4]Department of Chemical Sciences, Faculty of Science, Anchor University, Lagos, Nigeria. *https://orcid.org/0009-0007-1746-5786*

***Corresponding Author**: Micheal Abimbola Oladosu

DOI: *https://doi.org/10.5281/zenodo.24522881*

Article History

Original Research Article

Received: 01 October 2026

Accepted: 03 November 2026

Published: 25 November 2026

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial **4.0 International License (CC BY-NC 4.0),** which permits non-commercial use, sharing, and reproduction in any medium, provided the original author(s) and source are appropriately credited.

Citation: Evelyn Uzoamaka Onwuka, Micheal Abimbola Oladosu, Moses Adonduah Abah & Odu Ruth Odey. (2026). Addressing maternal and family health challenges through preventive and personalized medicine. UKR Journal of Medicine and Medical Research (UKRJMMR), 2(6), 71-77.

Abstract

Maternal and family healthcare are increasingly shaped by a shift away from uniform, reactive management toward preventive and personalized medicine, in which genetic, biomarker, and lifestyle information are used to stratify individual risk and tailor intervention before disease manifests. This review synthesises literature published between 2020 and 2025 on the application of preventive and personalized medicine across three interconnected domains of maternal and family health: (i) preconception and prenatal precision screening, including expanded carrier screening, cell-free DNA-based prenatal testing augmented by artificial intelligence, and biomarker-driven preeclampsia risk prediction; (ii) personalized medicine in family healthcare, encompassing precision nutrition in reproductive health and pharmacogenomic-guided prescribing in primary care; and (iii) polygenic risk scores as an emerging tool for family-based chronic disease prevention. Drawing on peer-reviewed evidence from Human Reproduction, European Journal of Human Genetics, npj Digital Medicine, Nutrients, Pharmacogenomics, and BMJ Medicine, among others, the review finds consistent evidence that precision screening and risk-stratification tools can identify at-risk individuals and couples earlier and more accurately than conventional approaches, while implementation remains constrained by counselling capacity, cost, workforce training, and uneven translation of research-grade models into routine primary care. Three comparative tables summarise preconception/prenatal precision screening technologies, personalized pharmacological and nutritional interventions in family healthcare, and polygenic-risk-score applications in preventive care, while three figure prompts are proposed to visualise the preventive-personalized medicine framework across the maternal-family life course, the precision prenatal screening and risk-stratification pathway, and the polygenic-risk-score-informed family preventive care model. The review concludes that realising the preventive potential of personalized medicine in maternal and family health requires parallel investment in genetic counselling infrastructure, provider training, and equitable access, alongside continued validation of risk models across diverse populations.

Keywords: *Preventive medicine, Personalized medicine, Precision medicine, Maternal health, Family medicine, Genetic screening, Polygenic risk score, Pharmacogenomics.*

1. Introduction

Maternal and family healthcare have traditionally relied on population-level guidelines applied uniformly across patients, an approach that manages risk at the group level but is often poorly matched to any individual patient's

actual genetic, physiological, or lifestyle risk profile. Preventive and personalized medicine reframes this model by using genetic, biomarker, and contextual data to identify risk before disease onset and to tailor screening, counselling, and treatment accordingly. In obstetrics specifically, this shift has been described as a transition from reactive management of pregnancy complications toward proactive, biomarker- and genomics-informed risk stratification spanning the preconception, antenatal, and postnatal periods [1].

This transition is visible across several distinct but converging strands of practice. In reproductive and preconception care, expanded carrier screening using next-generation sequencing has moved from ethnicity-targeted testing toward population-wide, panel-based screening capable of identifying couples at risk of having a child with a serious autosomal recessive or X-linked condition before conception occurs [2]. In prenatal risk assessment, artificial intelligence applied to cell-free DNA and other routinely collected clinical data is being used to improve the accuracy of both structural anomaly detection and pregnancy-complication prediction [3,4]. In family and primary care more broadly, pharmacogenomic testing and, more recently, polygenic risk scores are being piloted as tools to personalize prescribing and preventive counselling for common chronic diseases that run in families [5,6]. This review synthesises these strands to address a single, integrative question: how is preventive and personalized medicine being applied across the maternal-family health continuum, and what factors determine whether these tools translate into improved, equitable preventive care?

Specifically, this review addresses three questions: (1) What preconception and prenatal precision screening technologies are being used to identify maternal and foetal risk before or early in pregnancy? (2) How are personalized pharmacological and nutritional strategies being applied to family healthcare? (3) What is the evidence for polygenic risk scores as a tool for family-based preventive medicine, and what implementation barriers do they face?

2. Review Methodology

This narrative review synthesises peer-reviewed literature indexed in PubMed/MEDLINE, ScienceDirect (Elsevier), Nature-portfolio journals, MDPI, Oxford University Press, and SAGE, restricted to publications from 2020 to 2025. Search terms combined "precision medicine", "personalized medicine", "preventive medicine", "maternal health", "family medicine", "carrier screening", "cell-free DNA", "preeclampsia prediction", "pharmacogenomics", "precision nutrition", and "polygenic risk score" across title, abstract, and keyword fields. Priority was given to systematic reviews, cohort studies, and empirically validated risk-prediction or implementation studies published in indexed journals, and sources lacking verifiable digital object identifiers (DOIs) or peer-review status were excluded to ensure citation traceability.

3. Preconception and Prenatal Precision Screening

Expanded carrier screening (ECS) is among the most mature applications of preventive genomics in maternal healthcare. A large clinical validation study evaluating population-wide, panel-based ECS in both in vitro fertilisation and general-population settings found that next-generation-sequencing-based screening identified reproductive genetic risk that would have been missed by traditional, ethnicity-targeted screening approaches, supporting its clinical validity and utility for informed reproductive decision-making [2]. Complementing this clinical evidence, patient-experience research indicates that couples who undergo ECS generally value the information gained, though many report needing more preparation and support to interpret carrier results and understand residual risk, underscoring that the clinical utility of ECS depends substantially on accompanying genetic counselling capacity rather than the test alone [7]. Qualitative research with relatives of patients affected by a severe recessive disorder similarly found that motivations for and concerns about ECS uptake vary across personal disease experience, family history, and broader population-screening contexts, indicating that a one-size-fits-all counselling approach is unlikely to serve all prospective parents equally well [8].

Beyond preconception screening, artificial intelligence is being integrated into prenatal diagnostic and risk-prediction pipelines. A study combining cell-free DNA analysis with machine learning achieved accurate prenatal detection of foetal congenital heart defects, illustrating how AI-augmented liquid biopsy approaches can extend the diagnostic reach of routinely collected prenatal blood samples beyond their original screening purpose [3]. In parallel, electronic-medical-record-based machine-learning models have been developed to predict preeclampsia risk continuously across the antepartum, intrapartum, and postpartum periods using routinely collected clinical data rather than dedicated biomarker panels, achieving high predictive accuracy and offering a pathway toward personalized, precision-timed preventive intervention such as aspirin prophylaxis [4]. A complementary multistage biomarker-based prediction model validated in a large Chinese cohort demonstrated that risk-screening accuracy for pre-eclampsia improves substantially as pregnancy progresses, supporting a staged, personalized screening strategy rather than a single first-trimester assessment [9]. Figure 1 presents the Preventive and personalized medicine framework across the maternal-family life. Table 1 shows the Preconception and Prenatal Precision Screening Technologies.



Figure 1. Preventive and personalized medicine framework across the maternal-family life course, spanning preconception genetic screening, precision prenatal risk prediction, personalized family pharmacotherapy and nutrition, and polygenic-risk-informed chronic disease prevention

Sources: Adapted from references [1–3,5].

Table 1. Preconception and Prenatal Precision Screening Technologies

Screening/Prediction Technology	Clinical Application	Evidence Type	Key Reported Finding	Ref.
Expanded carrier screening (NGS panel-based)	Preconception identification of recessive/X-linked disease risk	Clinical validation study, IVF and general population	Detected reproductive genetic risk missed by ethnicity-targeted screening	[2]
Patient experience with ECS	Preconception counselling and decision support	Cohort evaluation, university hospital screening offer	Couples valued ECS but needed more support interpreting results	[7]
Qualitative ECS motivations/concerns	Preconception screening uptake in at-risk relatives	Focus group study	Motivations and concerns vary by personal/family disease experience	[8]
AI-augmented cell-free DNA analysis	Prenatal detection of fetal congenital heart defects	Diagnostic accuracy study	Accurate prenatal detection using AI applied to cfDNA data	[3]
EMR-based ML preeclampsia prediction	Continuous ante-/intra-/postpartum preeclampsia risk prediction	Large retrospective EMR cohort (>100,000 pregnancies)	High predictive accuracy (AUC 0.82-0.92) across pregnancy stages	[4]
Multistage biomarker prediction model	Staged pre-eclampsia risk screening across gestation	Retrospective cohort, Chinese population (n=20,582)	Screening accuracy improved from 0.71 to 0.95 AUROC as pregnancy progressed	[9]

4. Personalized Medicine in Family Healthcare: Nutrition and Pharmacogenomics

Personalized medicine extends beyond genetic screening into the tailoring of nutritional and pharmacological interventions for individual family members. In reproductive health, precision nutrition applies individual metabolic, genetic, and microbiome data to dietary guidance across the preconception, pregnancy, and lactation periods, with evidence suggesting that individually tailored nutritional strategies can influence fertility outcomes and pregnancy-related metabolic risk more effectively than generic dietary advice, although the evidence base remains at an earlier stage of clinical translation than genetic screening [10]. This nutrition-focused personalization

complements, rather than replaces, the genomics-focused preventive strategies discussed in Section 3, together forming a broader precision preconception and pregnancy care model.

In family and primary care prescribing more broadly, pharmacogenomic (PGx) testing has been piloted as a tool to personalize medication selection and dosing based on an individual's drug-metabolism genotype. A structured review of PGx implementation models in primary care settings identified feasibility across several small-scale programmes, highlighting the importance of pre-test counselling, pharmacist involvement, and integration of results into the electronic medical record and point-of-care clinical decision-support systems, while noting that most implementation to date has occurred in small feasibility studies rather than at scale [5]. A more recent pharmacist-led primary care PGx medication-management service, implemented across multiple clinic sites within an integrated United States health system, demonstrated substantial growth in patient uptake following the introduction of a standardised institutional guidance document, illustrating a practical pathway by which pharmacogenomic personalization can be operationalised within existing family/primary care infrastructure rather than requiring entirely new clinical pathways [11].

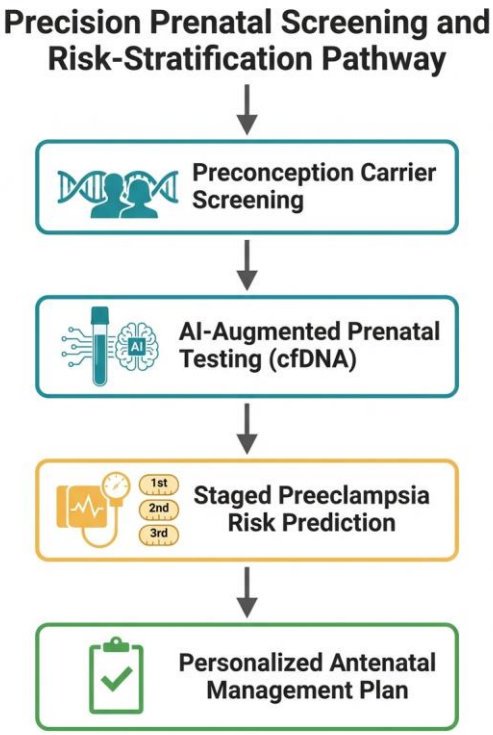


Figure 2. Precision prenatal screening and risk-stratification pathway, from preconception carrier screening through AI-augmented prenatal testing and staged preeclampsia risk prediction, feeding into personalized antenatal management

Sources: Adapted from references [2–4,9].

Table 2. Personalized Pharmacological and Nutritional Interventions in Family Healthcare

Intervention Domain	Personalization Basis	Setting/Population	Reported Outcome/Status	Ref.
Precision nutrition in reproductive health	Individual metabolic/genetic/microbiome profile	Preconception, pregnancy, and lactation	Tailored nutrition strategies linked to improved fertility and metabolic outcomes	[10]
Pharmacogenomic (PGx) panel testing implementation	Drug-metabolism genotype-guided prescribing	Primary care/community settings (multi-study review)	Feasible in small studies; pharmacist role and CDSS integration key enablers	[5]
Pharmacist-led PGx medication management service	Institutional PGx guidance document and pharmacist consultation	Integrated US health system, multiple primary care clinics	Growth to nearly 2,000 PGx visits after standardised implementation	[11]

5. Polygenic Risk Scores for Family-Based Preventive Medicine

Polygenic risk scores (PRS), which aggregate the effects of many common genetic variants into a single estimate of disease susceptibility, represent an emerging extension of preventive personalized medicine from single-gene and carrier-based approaches toward common, multifactorial chronic diseases relevant to family health, such as cardiovascular disease, cancer, and diabetes. Qualitative research examining patient understanding of polygenic risk information in primary care found that patients generally viewed PRS as a promising tool for enhancing preventive counselling and facilitating earlier identification of disease risk, though understanding of probabilistic risk concepts varied considerably and patients often sought clearer guidance on what specific preventive actions a given risk score should prompt [6]. This finding highlights that clinical benefit from PRS depends not only on predictive accuracy but on how effectively risk information is translated into actionable guidance during primary and family care encounters.

A large secondary analysis of the Polygenic Score Catalog, evaluating thousands of performance estimates across hundreds of polygenic risk scores and diseases, found that population screening performance varied substantially by disease and that median detection rates for a fixed false-positive rate were modest, illustrating that while some individuals identified as high-risk by PRS have substantially elevated odds of disease, PRS-based population screening currently performs best as a risk-stratification adjunct alongside established clinical risk factors rather than as a standalone screening test [12]. Considered together with the pharmacogenomic and nutritional personalization discussed in Section 4, this evidence suggests that family-based preventive medicine is moving toward a multi-layered model in which polygenic and monogenic genetic information, biomarker-based risk prediction, and lifestyle/nutritional personalization are combined, rather than any single technology serving as a complete preventive solution on its own.

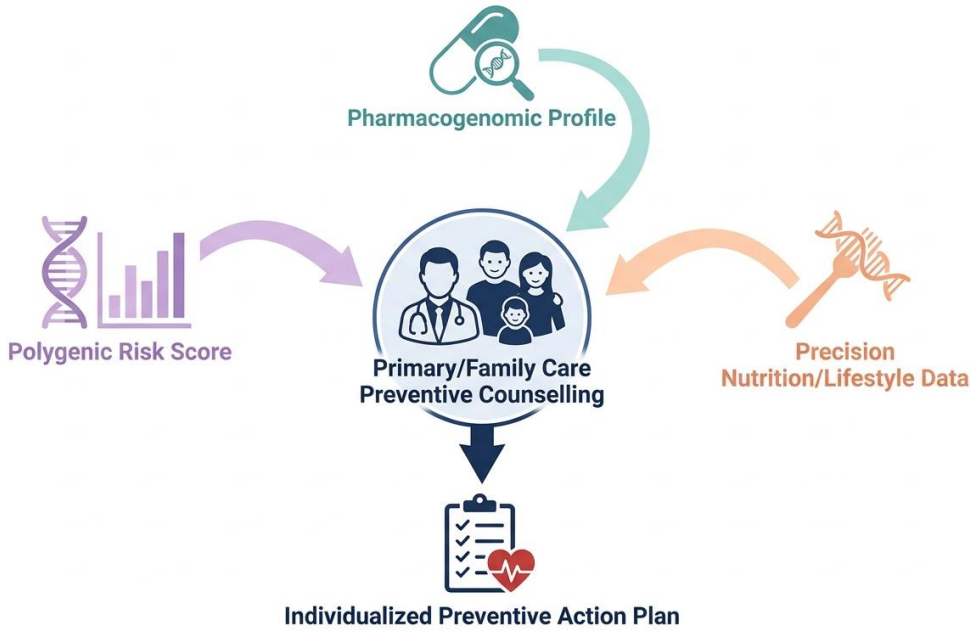


Figure 3. Polygenic-risk-score-informed family preventive care model, showing how PRS-based chronic disease risk stratification integrates with pharmacogenomic prescribing and precision nutrition to guide individualized preventive counselling in primary/family care.

Sources: Adapted from [5,6,10,12].

Table 3. Polygenic Risk Score Applications in Preventive Family Medicine

Application	Study Design	Population/Diseases	Key Reported Finding	Ref.
Patient understanding of polygenic risk information	Semi-structured qualitative interviews	Primary care patients, multiple chronic conditions	PRS viewed as valuable but risk communication and actionability need improvement	[6]
PRS performance across screening/prediction/stratification	Secondary analysis, Polygenic Score Catalog (3,915 estimates)	310 diseases including coronary artery disease and breast cancer	Modest population-screening performance; stronger utility as risk-stratification adjunct	[12]

6. Discussion And Future Directions

Three cross-cutting observations emerge from this review. First, preventive and personalized medicine in maternal and family health is most advanced at the single-gene and monogenic level (expanded carrier screening, pharmacogenomic prescribing) and least mature at the polygenic, multifactorial level, where risk-prediction performance and communication of actionable guidance both remain works in progress [2,5,6,12]. Second, across every domain examined, technical accuracy alone was insufficient for clinical benefit: carrier screening required counselling infrastructure [7,8], preeclampsia prediction models required staged, pregnancy-appropriate deployment [4,9], and pharmacogenomic testing required pharmacist and clinical-decision-support integration to translate into sustained clinical use [5,11]. Third, the maternal and family health domains reviewed here are converging on a layered preventive model, in which genetic, biomarker, and lifestyle/nutritional data are combined rather than deployed as isolated tools, suggesting that future clinical workflows will need to integrate outputs from multiple personalized-medicine technologies into a single, coherent preventive care plan [10,12].

Future research and practice should prioritise: (i) validation of prenatal and polygenic risk-prediction models across diverse and underrepresented populations, given that much current evidence derives from specific national or ethnic cohorts; (ii) investment in genetic counselling and health-communication infrastructure commensurate with the pace of screening technology adoption, rather than treating counselling capacity as a secondary concern; (iii) integration of pharmacogenomic, nutritional, and polygenic risk data into shared clinical decision-support systems usable within routine family and primary care encounters; and (iv) health-economic evaluation of preventive and personalized interventions across the maternal-family continuum to inform equitable reimbursement and scale-up decisions.

7. Conclusion

Preventive and personalized medicine is reshaping maternal and family healthcare by enabling risk identification before disease onset, from preconception carrier screening and AI-augmented prenatal testing through pharmacogenomic-guided prescribing and polygenic risk stratification. The evidence reviewed here indicates that these technologies are clinically valid and increasingly implementable, but that their preventive benefit depends on parallel investment in genetic counselling, provider training, clinical decision-support integration, and communication of risk information in ways patients can act upon. Realising the full promise of preventive and personalized medicine for maternal and family health will require treating counselling, workforce readiness, and equitable access as integral components of implementation, not as afterthoughts to technological development.

Acknowledgments

The authors acknowledge the contributions of researchers worldwide whose published work forms the foundation of this review.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding:

There is no funding for this review work

Author's Contribution:

All authors have read and approved the final manuscript and agreed to be accountable for all aspects of the work.

References

1. Bertozzi S, Corradetti B, Fruscalzo A, Londero AP. Editorial: precision medicine in obstetrics: pregnancy complication. J Pers Med. 2023;13(2):305. doi:10.3390/jpm13020305
2. Capalbo A, Fabiani M, Caroselli S, Poli M, Girardi L, Patassini C, Favero F, Cimadomo D, Vaiarelli A, Simon C, Rienzi LF, Ubaldi FM. Clinical validity and utility of preconception expanded carrier screening for the management of reproductive genetic risk in IVF and general population. Hum Reprod. 2021;36(7):2050-61. doi:10.1093/humrep/deab087
3. Bahado-Singh R, Friedman P, Talbot C, Aydas B, Southekal S, Mishra NK, Guda C, Yilmaz A, Radhakrishna U, Vishweswaraiah S. Cell-free DNA in maternal blood and artificial intelligence: accurate prenatal detection of fetal congenital heart defects. Am J Obstet Gynecol. 2023;228(1):76.e1-76.e10. doi:10.1016/j.ajog.2022.07.062
4. Li S, Wang Z, Vieira LA, Zheutlin AB, Ru B, Schadt E, Wang P, Copperman AB, Stone JL, Gross SJ, Kao YH, Lau YK, Dolan SM, Schadt EE, Li L. Improving preeclampsia risk prediction by modeling pregnancy trajectories from routinely collected electronic medical record data. NPJ Digit Med. 2022;5(1):68. doi:10.1038/s41746-022-00612-x
5. Hayward J, McDermott J, Qureshi N, Newman W. Pharmacogenomic testing to support prescribing in primary care: a structured review of implementation models. Pharmacogenomics.

2021;22(12):761-76. doi:10.2217/pgs-2021-0032

6. Pacyna JE, Ennis JS, Kullo IJ, Sharp RR. Examining the impact of polygenic risk information in primary care. J Prim Care Community Health. 2023;14:21501319231151766. doi:10.1177/21501319231151766

7. van Dijke I, Lakeman P, Sabiri N, Rusticus H, Ottenheim CPE, Mathijssen IB, Cornel MC, Henneman L. Couples' experiences with expanded carrier screening: evaluation of a university hospital screening offer. Eur J Hum Genet. 2021;29(8):1252-8. doi:10.1038/s41431-021-00923-9

8. Conijn T, van Dijke I, Haverman L, Lakeman P, Wijburg FA, Henneman L. Preconception expanded carrier screening: a focus group study with relatives of mucopolysaccharidosis type III patients and the general population. J Community Genet. 2021;12(3):311-23. doi:10.1007/s12687-021-00519-2

9. Tang Z, Ji Y, Zhou S, Su T, Yuan Z, Han N, Jia J, Wang H. Development and validation of multi-stage prediction models for pre-eclampsia: a retrospective cohort study on Chinese women. Front Public Health. 2022;10:911975. doi:10.3389/fpubh.2022.911975

10. Ahmad F, Calabrese CM, Terranegra A. The era of precision nutrition in the field of reproductive health and pregnancy. Nutrients. 2023;15(14):3128. doi:10.3390/nu15143128

11. Taylor K, Umbreit A, Lea C, Holm E, Kosloski Tarpenning K. Implementing a pharmacist-led primary care pharmacogenomics medication management service. Innov Pharm. 2024;15(2):10.24926/iip.v15i2.6178. doi:10.24926/iip.v15i2.6178

12. Hingorani AD, Gratton J, Finan C, Schmidt AF, Patel R, Sofat R, Kuan V, Langenberg C, Hemingway H, Morris JK, Wald NJ. Performance of polygenic risk scores in screening, prediction, and risk stratification: secondary analysis of data in the Polygenic Score Catalog. BMJ Med. 2023;2(1):e000554. doi:10.1136/bmjmed-2023-000554